DOCUMENT RESUME

ED 261 802 PS 015 367

AUTHOR Caruso, David A.
TITLE Individual Differences in the Variety of Sensorimotor Schemes Infants Use to Explore Objects: Relationships to Quality of Exploration and Problem-Solving Behavior.
PUB DATE Jun 84
NOTE 16p.; Paper presented at the Annual Symposium of the Jean Piaget Society (14th, Philadelphia, PA, June 6-8, 1984).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Cognitive Development; *Exploratory Behavior; *Individual Differences; *Infant Behavior; *Perceptual Motor Learning; *Problem Solving
IDENTIFIERS *Piagetian Theory

ABSTRACT

Infants' exploration of their environment has been considered by Piaget and others to provide a vehicle for cognitive development. Little research, however, has examined in detail what infants actually do while exploring or how exploratory behavior is related to other aspects of cognitive functioning. The present investigation was designed to address both of these issues by studying individual differences in a number of qualitative aspects of exploratory behavior and the relationship of these differences to problem-solving behavior in 1-year-old infants. Forty infants of middle-class parents were observed on exploratory and problem-solving tasks using predetermined behavior checklists to test the hypothesis that infants who use a number of different schemes during exploration will be more likely to solve the structured problem-solving tasks than infants who use fewer schemes. The number of schemes used to explore was found to be positively correlated with both success and sophistication in problem-solving. Also, a number of interesting relationships were found between the number of schemes used and other aspects of exploratory behavior. The results are interpreted in terms of Piaget's analysis of the coordination of schemes in sensorimotor stage four. (Author/RH)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED261802

"Individual Differences in the Variety of Sensorimotor Schemes Infants use to Explore Objects: Relationships to Quality of Exploration and Problem-Solving Behavior." Paper presented at the Fourteenth Annual Symposium of the Jean Piaget Society, May, 1984.

David A. Caruso

Early Childhood Education
Indiana State University
Terre Haute, IN 47809

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

David A. Caruso

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Abstract

Infants' exploration of their environment has been considered by Piaget and others to provide a vehicle for cognitive development. Little research, however, has examined in detail what infants actually do while exploring. The focus of this study was on the developmental implications of individual differences in the variety of sensorimotor schemes infants use to explore at one year of age. The relationships between this and other aspects of exploratory behavior and to problem-solving behavior were assessed. 40 middle-class infants were observed on exploratory and problem-solving tasks using pre-determined behavior checklists. The number of schemes used to explore was found to be positively correlated with both success and sophistication in problem-solving. Also, a number of interesting relationships were found between the number of schemes used and other aspects of exploratory behavior. The results are interpreted in terms of Piaget's analysis of the coordination of schemes in sensorimotor stage 4. The potential of this general framework for studying individual differences at developmental transition points is also discussed.

PS 015367

Introduction

Recent interest in infant's exploratory behavior has been stimulated by the point of view of Piaget and others that it both results from and contributes to curiosity about, and the need to deal competently with, the environment. From this perspective, exploratory behavior is seen as a primary way that the young organism enhances its adaptability, learning, and cognitive development. While a great deal of research has studied properties of the environment that elicit exploration and the amount of time spent exploring different stimuli, relatively little has examined in detail what infants actually do while exporing or how exploratory behavior is related to other aspects of cognitive functioning. The present investigation was designed to address both of these latter issues by studying individual differences in a number of qualitative aspects of exploratory behavior and their relationship to problem solving behavior in one year old infants.

Research Objectives

The research had several general objectives including developing fine grained observational measures of individual differences in naturalistic exploratory behavior, describing these individual differences in terms of the interrelationships among the aspects measured, and examining the relationship between exploratory behavior and cognitive functioning in terms of problem-solving behavior on structured tasks. The central concern

of the research, however, was a predictive hypothesis conceptualized in light of Piaget's account of cognitive development during the sensori-motor period.

In Piaget's (1952) analysis of cognitive development during infancy the concept of the sensori-motor scheme plays a central role. In his view, the elaboration, differentiation, and recombination of behavioral schemes makes possible increasingly intelligent transactions with the environment beginning at about 10 to 12 months of age in sensori-motor stage 4. Piaget asserted that the onset of many cognitive abilities at about this age, such as means-end behavior, searching for a hidden object, and anticipation, are the result of this new ability to coordinate several schemes in novel ways that are detached from their usual behavioral context. In light of this perspective, I suggested that if schemes do play such an important role in the development of these aspects of early cognition, then the number of different schemes in an infant's behavioral repertoire may have significant implications for other aspects of cognitive functioning. In other words, if the infant brings more different schemes to bear upon the environment during exploration, there may be greater opportunity for the coordination of two or more schemes in order to engage in more sophisticated cognitive activity. Therefore, it was hypothesized that infant's who use more different schemes during exploration will be more likely to solve the structured problem-solving tasks.

The focus of this paper will be on the findings of the study

with regard to this hypothesis and the implications they suggest for understanding the range of individual differences in exploratory and problem-solving behavior. The potential of this general framework for studying individual differences at developmental transition points will also be discussed.

Method

Subjects

The subjects for the study were forty 11 and 12 month old infants from predominantly middle-class homes. The sample consisted of 22 male and 18 female infants with 23 being first-born and 17 later-born in order to control for gender and birth order differences.

Procedure

The research was conducted in an infant research lab where the child's behavior could be observed and recorded from behind one-way glass. Each infant was presented with four separate sets of task materials. The first two consisted of sets of toys used to measure initial exploration of objects. The other two were structured problem-solving tasks and required the child to retrieve a toy from behind a clear plexiglass barrier. The tasks were timed to last no longer than 4 minutes each since the research focused on initial exploration of objects rather than on in depth play.

Measures

Specific behaviors were coded on behavior check-lists in terms of their presence or absence during any ten-second interval. All appropriate behaviors that occur during a given ten-second interval were checked. Examples of exploratory behaviors recorded are squeeze, finger manipulate, visual examination, bang, combine, mouth, and so forth. A box to indicate no appropriate behaviors for any ten-second interval was also provided. When the same behavior continued from one ten-second interval to the next it was indicated with a "c" rather than a check mark in order to differentiate between an initiation of a different exploratory or problem-solving behavior and simply the continuation of a behavior initiated previously.

The interjudge reliability of the coding system was assessed for all behavior categories and the resulting correlation coefficients were between .83 and 1.00 with a mean of .92. A number of measures of spacific aspects of both exploratory and problem-solving behavior were then calculated from the behavioral records. For exploratory behavior these included:

1. Number of different "schemes" used to explore.
2. Number of each type of exploring used.
   (visual, fine motor, combining, gross motor, mouthing)
3. Number of alterations of each scheme used.
4. Behavioral tempo of exploration.

5. Quantity of exploring.

   - percent of time available spent exploring.
   - total number of initiated exploratory acts.

Problem-solving behavior:

1. Persistence in problem-solving.
2. Changing behavior in attempts to solve.
3. Achieving solution of problem.
4. Level of cognitive sophistication in problem-solving.

Points		Behavior
4	-	Quick, easy solution: seems to anticipate before acting.
3	-	Solves after considerable trial and error.
2	-	Solves only after first prompt which involves pointing to solution.
1	-	Solves only after second prompt which involves demonstrating solution.
0	-	Fails to solve even after two prompts.

Results

In the following section I will highlight several findings of the study which are particularly relevant to the major hypothesis and then briefly discuss their implications for furthering our understanding the importance of individual differences in exploratory behavior for cognitive functioning during infancy.

Descriptive Statistics

The range of individual difference scores on the exploratory measures was quite large. On most variables the highest score was two to three times as great as the lowest. For example, the "behavioral tempo" of some infants was twice as fast as others and the "total number of exploratory acts" used by some exceeded others by a ratio of almost 3 to 1. The number of different schemes used to explore ranged from a low of 2 to a high of 9.

Similarly wide ranges of scores were found on the problem-solving measures. The behavior of the infants in actually solving the tasks is characterized, in part, by a scale from zero to four based on the quality of their solution as discussed above. Eighteen of the 40 infants were able to solve at least one of the tasks. Of these solvers, 9 solved only after two prompts that demonstrated the solution, 2 solved after one prompt, 3 required no prompts but used considerable trial and error, and 4 solved very quickly with little or no trial and error. Only four of the infants solved both of the problem-solving tasks.

Relationships between Exploratory and Problem-Solving Measures

The central question of the study concerned the relationship between the number of schemes used to explore and problem-solving behavior on the structured tasks. Also of interest was the relationship of other aspects of exploratory behavior to the

number of schemes used and to problem-solving. It was found that the mean number of schemes used to explore was positively correlated with both success and cognitive sophistication in problem-solving, whereas no other measure of exploratory behavior was related to problem-solving behavior. In other words, infants who used a greater number of schemes to explore had a higher score for cognitive sophistication in problem-solving ($r=.29$) and were more likely to be in the group of 18 infants who solved at least one of the tasks ($r = .36$). This finding is strengthened by the fact that the problem-solving measure of "changing" behaviors, which records the number of different behaviors used in attempts to overcome the barriers, was also positively correlated with success in problem-solving.

The meaning of the correlation between number of schemes used to explore and problem-solving ability is further clarified when the distribution of scores is examined for those infants who solved a barrier task. The range of scores for schemes used was between 4.0 and 9.0 averaged over both tasks. Of the 8 infants who used a low number of schemes (4.0 - 5.5) only one solved a barrier task. However, 6 of the 15 infants who used a moderate number of schemes (6.0 - 7.0) solved a task and 11 of the 17 infants with a high mean scheme score (7.5 - 9.0) were solvers. In other words, infants whose exploratory behavior was characterized by the use of very few different schemes were quite unlikely to solve a task relative to those infants using many schemes.

Given this relationship between the number of different schemes used to explore and success in problem-solving it is important to note that the mean-schemes variable was also related to a number of other aspects of exploratory behavior. For example, infants who used more schemes during exploration also had a faster behavioral tempo (r=.47), initiated more total exploratory acts (r=.52), explored a greater percentage of the time available (r=.56), and used more fine motor (r=.28) and gross motor (r=.37) behaviors.

Data Reduction

In order to further refine the analysis and clarify the role of number of different schemes used in relation to other aspects of exploratory and problem-solving behavior, a data reduction was carried out based on clusters of types of exploratory behavior. Two clusters of exploratory measures were constructed based on both conceptual considerations and their inter-correlations. These summary variables were then confirmed using a factor analysis procedure. The first cluster includes the fine motor behaviors, two types of visual exploring, and combining. The second cluster is composed of the gross motor behaviors and mouthing. This approach was based, in part, on previous research by Kagan (1971) and others which suggests that visual exploring, combining, and careful fine motor exploring are indicative of more sophisticated or cognitively advanced exploratory behavior.

The "number of schemes" used to explore and the "total number of exploratory acts" of schemes were calculated for each cluster. Correlations were then computed with the problem-solving measures. It was found that the use of more schemes on the fine motor cluster was positively correlated with success in problem-solving ($r=.31$), whereas number of schemes on the gross motor cluster was not significantly correlated with solving a task ($r = .13$). However, the use of more "schemes" on the gross motor cluster did correlate with a higher score for level of cognitive sophistication in problem-solving. It should also be noted that the quantity of total exploratory acts used for each cluster was not correlated with either of the variables that measure ability on the problem-solving tasks. In other words, it is not the total amount of exploring, but rather the quality of the behavior in terms of variety of different schemes used, that is related to problem-solving ability.

Discussion

Number of Schemes used to Explore

It will be remembered that the measure of number of schemes used during exploration was of interest, in large part, because of Piaget's assertion that the onset of many cognitive abilities in sensori-motor stage 4 results from the infant's new facility at coordinating or combining several schemes. Even though the correlations are modest, the fact that, in the present study,

the measure of the number of "schemes" used during exploration was found to be the only exploratory variable correlated with problem-solving behavior lends some support to Piaget's notion that sensorimotor schemes function as fundamental aspects of infant intelligence and play an important role in the transition to more sophisticated cognitive behavior at about 10 to 12 months of age. It also supports the present investigation's hypothesis that individual differences along this dimension should be related to the level of sophistication in other aspects of cognitive functioning. This interpretation is strengthened by the finding that a similar measure of using more different behaviors during problem-solving was also related to both success and sophistication on the barrier tasks. The fact that neither the level of persistence in problem-solving nor the quantitative measures of exploring were related to problem-solving ability further emphasizes the important role that the variety of behaviors that infants bring to bear on the environment plays in their cognitive functioning at one year of age.

Data Reduction

The results of the analyses using the data reduction procedure contributed to a more refined and clearer explanation of these relationships. As discussed above, the two clusters used were a "fine motor cluster", consisting of the fine motor, visual, and combining behaviors, and a "gross motor cluster" made up of the gross motor behaviors and mouthing. When the "mean

scheme" score for each cluster was correlated with the problem-solving measures it was found that the "fine motor cluster" carried most of the relationship between number of "schemes" used and success at problem-solving.

Taken as a whole then, these results indicate that the exploratory behavior of the infants who used more different "schemes" during exploration and were also more successful at solving the structured tasks were those whose exploring was characterized by greater amouunts of fine motor, visual, and combining activity. Additionally, their exploratory behavior was rather slow paced relative to the infants who used more schemes on the "gross motor cluster". However, the positive correlation found between number of schemes on the "gross motor cluster" and the level of sophistication in problem-solving does add further weight to the importance of number of "schemes" as a qualitative aspect of exploratory behavior. In other words, the use of more "schemes" is related to sophistication in problem-solving even when the exploratory behavior is characterized by fast paced, gross motor dominated activity.

Behavioral Tempo

This issue of the tempo of young infants' exploratory behavior was found to be important developmentally by a number of other investigators including Kagan (1971) and McCall (1972). Kagan, for example, considered slow paced, fine motor and visual exploration during infancy to be one of the best predictors of

childhood intelligence. Although the results of the present research do support Kagan's perspective, they also refine it somewhat. They suggest that it is not simply the pace of exploring, but also the qualitative content of the exploratory behavior, that is important since even though the behavior of the infants on the "fine motor cluster" was slower in tempo, it was those infants who used more "schemes" that were successful on the problem-solving tasks. Also, the finding that even fast paced babies, who used more gross motor activity, were more sophisticated in their problem-solving behavior if they used more "schemes" to explore, further supports the contention that rather than simply the tempo itself, it is the functional quality of the exploratory behavior that is significant with respect to problem-solving ability.

Summary and Conclusions

The present investigation examined in some detail the nature of individual differences in infants' exploratory behavior along a variety of qualitative and quantitative dimensions and their relationship to problem-solving behavior. Since the measure of number of schemes used to explore was the only aspect of exploratory behavior related to either success or sophistication at problem-solving, differences along this dimension can be used to generally characterize the nature of the infants exploratory behavior. The infants who used more "schemes" during exploration were found to be generally more interested, active, and

curious in their exploring. They explored more than the infants who used fewer "schemes" in terms of both total exploratory interactions with the toys and percentage of time available used to explore. This finding is interpreted to suggest that the availability of more different "schemes" in a babies exploratory repertoire may result in the possibility of more interesting interactions with the environment and therefore in increased curiosity and interest in pursuing exploration.

The finding that the use of more "schemes" is related to successful and sophisticated problem-solving behavior was interpreted in light of Piaget's conceptualization of infant intelligence to suggest that the availability of more schemes presents more opportunities for their creative and insightful combination and coordination in order to overcome the barriers in the problem-solving tasks.

The approach to studying individual differences used in this study was based on measuring qualitative features of cognitive functioning along dimensions that Piagetian theory delineates as salient, particularly at important developmental transition points. This differs from the more commonly used approach of studying differences in the age of onset of various Piagetian stages or cognitive abilities. The results of the present research suggest that measuring qualitative aspects of the cognitive mechanisms involved in stage transitions can lead to more productive investigations of individual differences and their relationships to other aspects of cognitive functioning both contemporaneously and in later childhood.

REFERENCES

Kagan, J. Change and continuity in infancy. New York: Wiley, 1971.

McCall, R., Hogarty, P., and Hurlburt, N. Transitions in infant sensorimotor development and the prediction of childhood I.Q. American psychologist, 1972, 27, 728-748.

Piaget, J. The origins of intelligence in children. New York: International University Press, 1952.